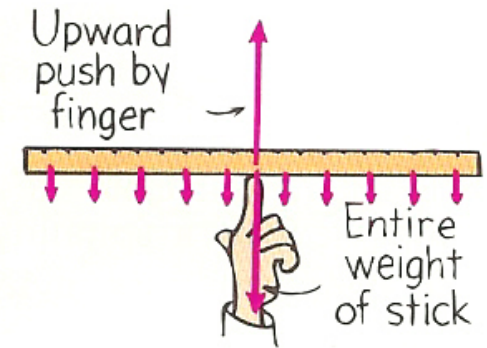


# Center of Gravity

# What is the Center of Gravity?

- The point in which gravity appears to be acting

- The point at which an object behaves as if all its weight were concentrated there
- the point at which an object can be balanced



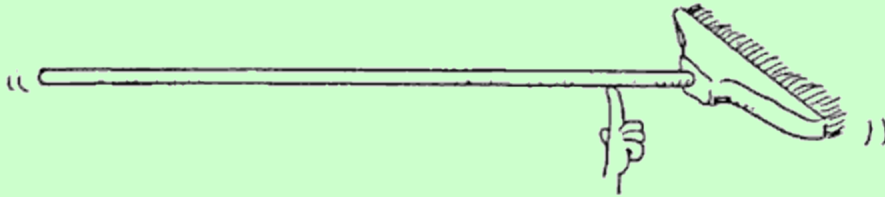
**FIGURE 7.15** The weight of the entire stick behaves as if it were concentrated at its center.

# Point of Balance

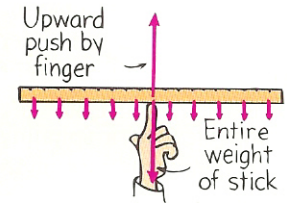
Why is an object balanced at the center of gravity?

- When an object is supported at its center of gravity there is no net torque acting on it, and it will remain in static equilibrium
- An object balanced at this point is able to free rotate about that point – add picture

# Broom vs. Meter Stick



- Broom and meter stick balanced at the center of gravity
- Why did one finger remain still or move slower than the other?
  - The finger that is closer to the center of gravity will have to support more weight and will feel more friction and move more slowly or remain still. The other finger will begin to slide closer to the center of gravity. The fingers may then alternate as they approach meeting at the center of gravity.



**FIGURE 7.15** The weight of the entire stick behaves as if it were concentrated at its center.

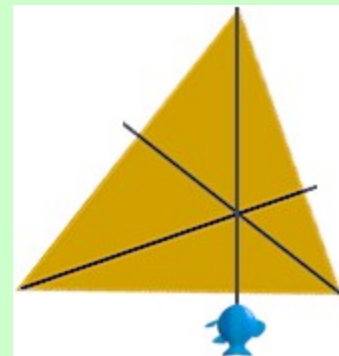
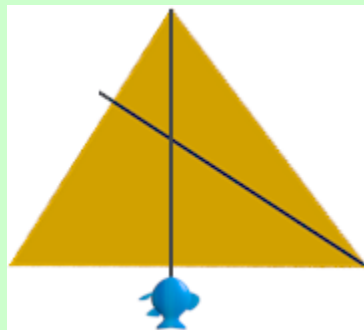
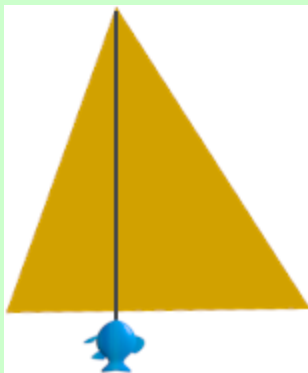
## Locating the Center of Gravity

- **Uniform objects** (meter stick) – Locate the center of gravity using symmetry. The center of gravity for a uniform object will be the exact geometric center.
- **Irregularly shaped objects** (broom) – you can locate the center of gravity experimentally.
  - Using a plumb line, you can suspend the object from various points (2 or more) and trace the plumb line's location each time.

# Locating the Center of Gravity

## Irregularly shaped objects

- The center of gravity of any suspended object lies directly beneath the point of suspension. The center of gravity will be located on a vertical line drawn from the suspension point.
- To locate this point, suspend the object from various points and draw vertical lines from the suspension point.
- The intersection of the lines is the point of the object's center of gravity.



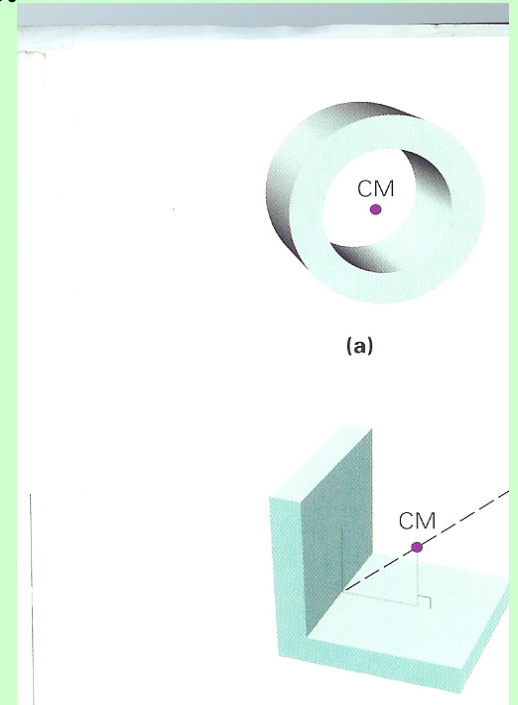
# Locating the Center of Gravity

- Which end of the broom was the center of gravity closer too?

- On an object of irregular shape, the center of gravity will be closer to the heavier end.

- Most of the time the center of gravity of an object is a point within the physical mass of the object. But it can also be located at a position that has no physical mass.

Picture of a donut  
boomerang high jumper



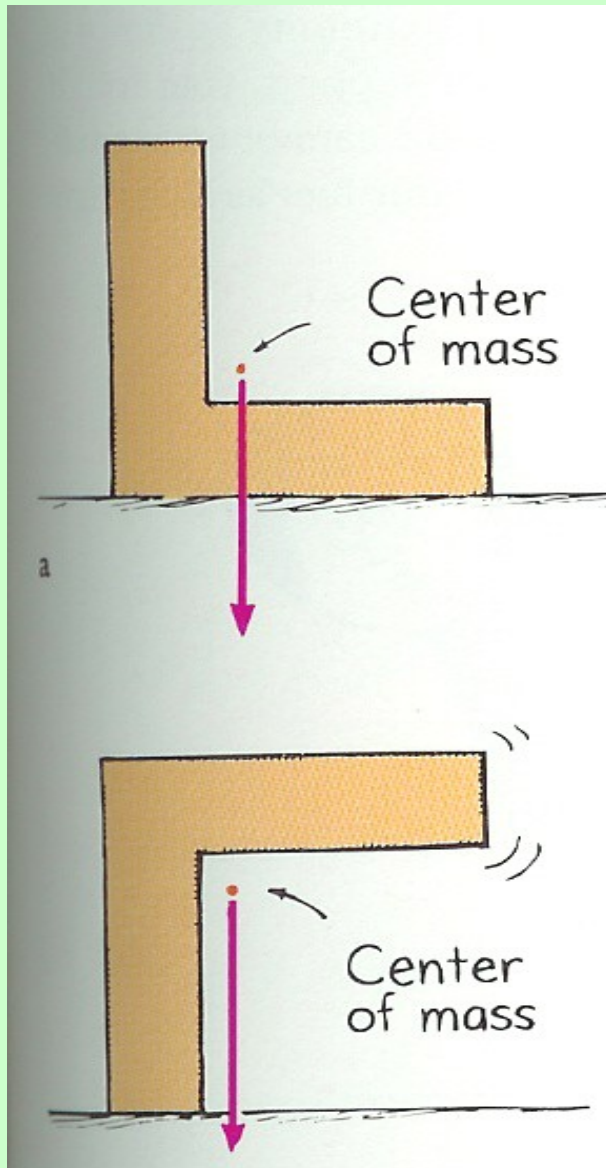
# Why do we care about the center of gravity?

## Stability!

Peg board demo Balancing toys

- The degree of stability in an object's position depends on how much its center of gravity will be changed if moved.
  - Stable equilibrium – occurs when a small displacement on an object results in a restoring torque that brings the object back to its original position
  - Unstable equilibrium – occurs when a small displacement on an object results in a torque that will rotate the object farther from its original position (falls over)

# Why do we care about the center of gravity?



- As long as a plumb line dropped from the center of gravity falls within the area of an object's base of support, the object will not all over.

Think back to peg boards –  
when was the board stable?

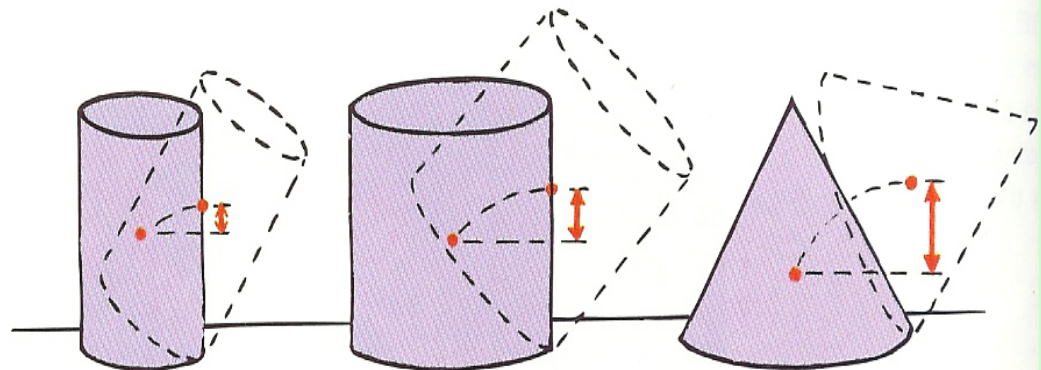
# What object shape will be the most stable (least likely to tip over)?

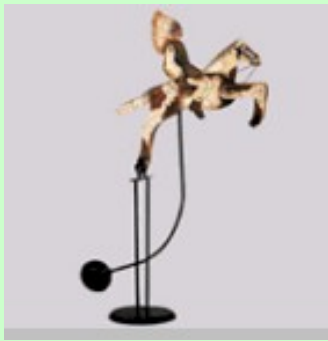
- Objects with wide bases and low centers of gravity are more stable and least likely to tip over

Insert picture of  
race car versus  
SUV

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**FIGURE 7.21** The vertical distance that the center of gravity is raised in tipping determines stability. An object with a wide base and low center of gravity is more stable.





## Balancing Toys – How do they work?

- If the pivot point (point of support) is on the same vertical line as the center of gravity, then the object is going to balance.
- When the toy is tipped, the center of gravity is raised resulting in gravity exerting a restoring torque which pulls it back toward the upright position.
- If the center of gravity is not inline with the pivot point then the object will rotate either clockwise or counter clockwise depending on which side has more torque.